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Research Article

Fertility Status of Soils in the Selected Regions of the Western Ghats of Karnataka, India

B. Sannappa, K.G. Manjunath
Department of Studies in Sericulture Science, University of Mysore, Manasagangotri, Mysore–570 006, India.

Corresponding author
Dr. B. Sannappa
Email: drbsannappa@yahoo.co.in

Abstract: The present study was an attempt to know the fertility status of soils in five selected regions (H.D.Kote, Madikeri, Sakaleshpur, Shimoga and Sirsi) of the Western Ghats of Karnataka with Mysore region as control for comparison for the purpose of exploration of wild (tree type) castor, *Ricinus communis* L., a primary host plant of the domesticated vanya silkworm, *Samia cynthia ricini* Boisduval. The selection of regions for drawing soil samples were based on the extent of area (Western Ghats) covered in Karnataka giving due weightage for the entire region. The soil samples were drawn at a depth of 0-45 cm from five spots of each region for collection of 250 g of composite samples adopting quadrant technique to study the chemical properties (pH, electrical conductivity, organic carbon, available nitrogen, phosphorus and potassium) of soils. The chemical properties of soils were statistically varied among the selected regions of the Western Ghats of Karnataka at 5% level of probability. pH and EC of soils varied between 5.25 (Sirsi) and 7.83 (Madikeri), 0.03 (Sirsi) and 0.28 (Shimoga) m.mhos/cm, respectively. Organic carbon and available nitrogen contents were significantly more (1.59% and 709.2 kg/ha) with H.D. Kote region and Sakaleshpur region recorded less contents (0.47% and 250.6 kg/ha). The soils of Madikeri region had higher available phosphorus content (34.34 kg/ha) and it was lower with Sirsi region (9.450 kg/ha). Both Madikeri and Sakaleshpur regions recorded highest potassium content of 717.0 kg/ha with least being in Sirsi region (90.00 kg/ha). The correlation co-efficients worked out for chemical properties of soils established non-significant relationship among them, except for organic carbon content, wherein it showed significant ($P \leq 0.01$) positive relationship with available nitrogen content of soils.
Keywords: Fertility, Western Ghats, Karnataka, Castor, *Samia cynthia ricini*

INTRODUCTION

Soil is the uppermost layer of variable depth of the earth consisting of loose material, which is the main support for natural vegetation and other life forms of our planet. Soil is "a natural surface layer containing living matter and supports various tissues". Soil is composed of different sized inorganic particulars, reactive and stable forms of organic matter, a myriad of living organism, water and gases. Soil organic matter is an important factor in evaluating management system of the forest soil fertility [1]. The forest soils vary in physico-chemical changes with time and space resulting in variation among topography, climate, weathering processes, vegetation cover and microbial activities and also biotic and abiotic factors [2].

The physical and chemical attributes of soil regulates soil biological activity and interchange of ions between the solid, liquid and gaseous phases which influence nutrient cycling, plant growth and decomposition of organic materials. Organic carbon content in soils has an index of available nitrogen. Organic matter is one of the important factors to determine quality of soil and serves as sources of nutrients for improving physical and biological properties of soils in addition to productivity. The soil chemical environment is dynamic and reactions that maintain dilute solution of nutrient elements are indispensable for continual plant growth. The nutrient transformation and its availability in soils depend on pH, clay minerals, cation and anion exchange capacity [3].

The Western Ghats comprises an area of around 160,000 km^2, with an elevation ranges from 300-2700 m mean sea level. It covers 34 biodiversity hotspots of the world and are a chain of mountain ranges stretching north to south along the western peninsular India [4]. The Western Ghats of Karnataka lies in southern states of India covers 20% of its geographical area. Karnataka is biodiversity rich region which has one of the mega diversities of the world, which comprises of climate, topography and soil. The Western Ghats of Karnataka is also known as Sahyadri. The soils have rich sources of nutrients and help to serve as a media for forest trees and thus aid for evaluating the fertility status. The types of soils present in Western Ghats of Karnataka are red, red sandy, alluvial, black soil and laterite soils.

The castor (*Ricinius communius*) is the primary food plants of eri silkworm, besides play an important role in oil seed production in the world. The perennial nature of castor plant makes it ideally situated for planting on field bunds and backyards. As a perennial tree, leaves can be used for feeding goats, animals, eri silkworm, etc., in addition to harvesting of

seeds for oil extraction [5]. Though castor grows on all types of soil, but heavy clay and poor drained soils are unsuitable for castor cultivation. The pH range of 5.0 to 6.5 is preferred for luxuriant growth of castor, but it also tolerates a pH upto 8.0 [6]. Keeping these points in view, an attempt has been made to know the fertility status of soils with special reference to chemical properties and its relationship in improving the physical and biological properties towards exploration and exploitation of wild (tree) castor.

MATERIALS AND METHODS

Study area

The study area consists of five selected regions of Western Ghats of Karnataka comprising H.D. Kote (HDK), Madikeri (MDK), Sakaleshpur (SKL), Shimoga (SHM) and Sirsi (SRS) along with Mysore (MYS) for comparison (Fig. 1 and Table 1).

Fig. 1: Maps of the study area - selected regions of Western Ghats of Karnataka

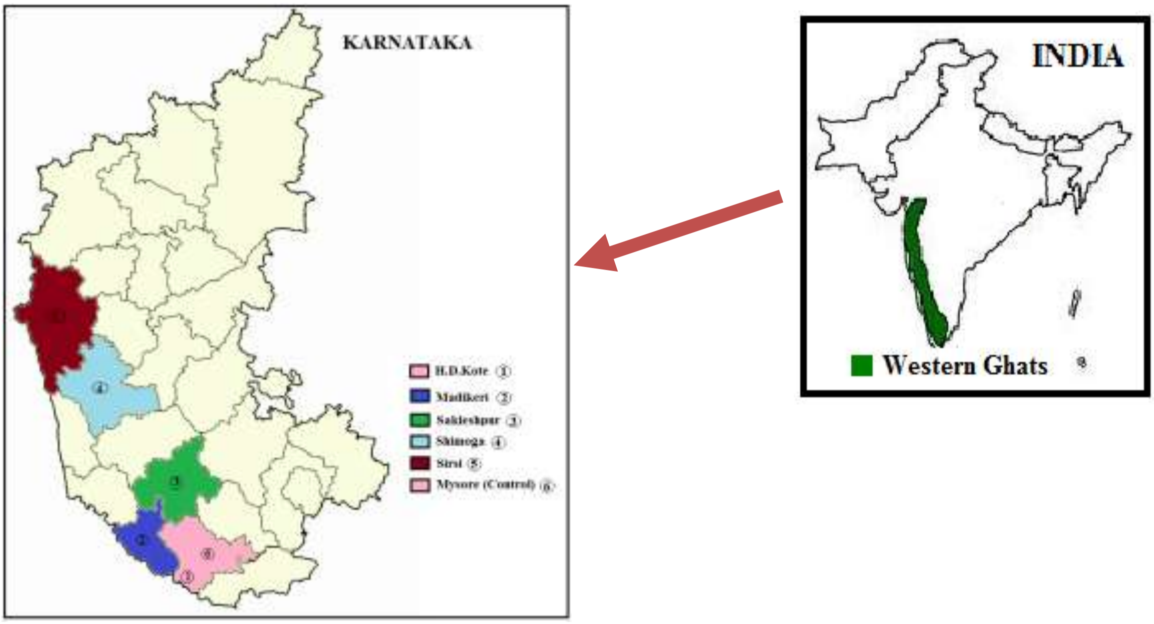

Table 1: Details of the study area - selected regions of Western Ghats of Karnataka

Sl. No.	Region	Latitude	Longitude	Altitude (MSL)
1.	H.D.Kote	12°05' N	76°19' E	694
2.	Madikeri	12°26' N	75°47' E	970
3.	Sakaleshpur	12°58' N	75°47' E	949
4.	Shimoga	12°56' N	75°38' E	569
5.	Sirsi	14°37' N	74°51' E	590
6.	Mysore (Control)	12°15' N	76°42' E	770

Collection of soil samples

The soil samples were collected from 5 to 6 spots from each region at a depth of 0-45 cm with 'v' shape pit by scraping the sides to collect 250 to 500 g of soil from each spot. The collected samples were mixed thoroughly and removed unwanted materials and pebbles. Further, composite samples of 250 g was collected from each region by adopting quadrant technique and were shade dried for 2-3 days and sieved with sieve plate of 2mm size and kept in air tight container. The soil samples were used for analyzing the following chemical properties.

Soil pH: pH is defined as negative logarithm of hydrogen ion concentration. The soil pH or soil reaction is indicated by acidity and/or alkalinity. The pH of the soil solution was measured using digital pH meter (Elico).

Organic carbon (%): Organic carbon is a carbon associated with organic matter from which organic fraction of soil made up of decomposed plant and animal materials with microorganisms. Organic carbon in soils was determined by Walkely and Black wet oxidation method [7].

Electrical Conductivity (m.mhos/cm): Electrical conductivity of soil is defined as the reciprocal of the electrical resistance of the extract of the soil which is one centimeter long and a cross-sectional area of one square centimeter. Electrical conductivity is measured

by Conductivity Bridge and it is expressed in milli mhos per centimeter [7].

Available Nitrogen (kg/ha): The available nitrogen content in soil was estimated by adopting alkaline potassium permanganate method [8]. A known quantity of soil was heated with Potassium permanganate solution and sodium hydroxide. The ammonia released was collected into 4% boric acid containing mixed indicator and nitrogen was titrated against 0.02 N sulphuric acid until develops pink colour as an end point.

Available Phosphorous (kg/ha): The phosphorous content in the soil extract was determined by the blue colour formed by ascorbic acid and colour intensity was read at 660 nm using spectrophotometer (Systronics) [7].

Available potassium (kg/ha): The available potassium was extracted with ammonium acetate from the known quantity of soil. The samples were extracted and fed to flame photometer (Systronics: SYS-121) [7].

Analysis of data

The data were statistically analyzed by adopting one-way completely randomized design at 5% level of significance. Further, data were subjected to variance - covariance and correlation analysis ($P \leq 0.01$ and $P \leq 0.05$). Variance is a measure of the dispersion of a set of data points around their mean value and it is a mathematical expectation of the average deviations from the mean, while covariance and correlation are related but not equivalent statistical measures. Covariance measures the degree to which two variables change or vary together (i.e., co-vary) and correlation refers to the relationship between two or more variables [9, 10].

RESULTS AND DISCUSSION

Soil pH: The soil pH influences the rate of nutrients release through its influence on decomposition, carbon exchange capacity and solubility of materials. Further, soil pH influences plant growth by way of improving the soil physical condition and nutrients availability, whereas, high or low pH of nutrient medium has adverse effect on plant growth. In the study, soil pH in the selected regions of Western Ghats of Karnataka registered greater amount of variations. Soil pH was significantly higher (7.83) in the Madikeri region, followed by Mysore (7.74), H.D. Kote (7.03), Shimoga (6.96) and Sakaleshpur (5.49). However, soil pH was lower in the Sirsi region (5.25) (Fig. 2 and Table 2). Overall, the mean value of pH of selected regions was 6.72 (Table 3). Further, pH of the soils are found positive non-significant relationship with other chemical properties of soils, however, pH value of soils had greater influence on available nitrogen and available potassium as evidenced by the variance and co-variance matrix values (Tables 4 and 5). Soil pH was higher (7.62) in Kodagu (Madikeri) region and lower in Dakshina Kannada (4.90) and Chikkamagalur (5.85) regions of Western Ghats of Karnataka [11]. The soils of eastern Himalayas were extremely acidic and surface horizons were having lower pH compared to sub-surface horizons [12]. The forest soils derived from gneiss and Schist type of parent material revealed that in most of the soil profiles, the soil pH did not show any specific trend with depth [13]. The pH of red soils varied between 3.9 and 7.0 in Western Ghats of Karnataka, as the high amount of rainfall was the major factor contributed to the increase in acidity in these soils.

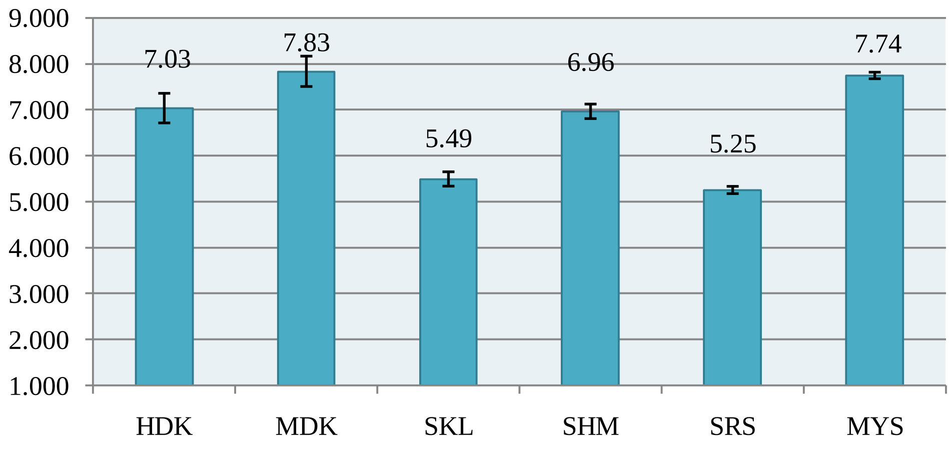

Fig. 2: pH of soils in selected regions of the Western Ghats of Karnataka

Electrical Conductivity (EC): The measure of electrical conductivity shows the total amount of soluble salts present in the soil. It is the most common measure of soil salinity. The variations found in respect of electrical conductivity among the soils of the selected regions of Western Ghats of Karnataka were significant. The electrical conductivity was significantly more in the Shimoga region (0.28 m.mhos/cm) followed by Sakaleshpur, Mysore, Madikeri and H.D. Kote regions (0.25, 0.19, 0.16, and 0.09 m.mhos/cm, respectively). However, electrical conductivity was less in Sirsi region (0.03 m.mhos/cm) (Fig. 3 and Table 2). The mean value of electrical conductivity in the selected regions of Western Ghats of Karnataka was 0.17 m.mhos/cm (Table 3). Electrical conductivity had negative non-significant correlation with organic carbon and available nitrogen contents and was positive non-significant relationship with pH, available phosphorous and available potassium contents of soils. Similar trend too observed with variance and covariance matrix (Tables 4 and 5). Soil with electrical conductivity values greater than 4 ds/m are considered as saline [14]. It was observed that the electrical conductivity values in the soils of Western Ghats of Karnataka ranged from 0.1 to 0.4 ds/m indicating no accumulation of salts in the soils [15]. Whereas, electrical conductivity in the soils of northern Karnataka ranged from 13.8 ds/m to 23.1 with decreasing in depth of soils [16].

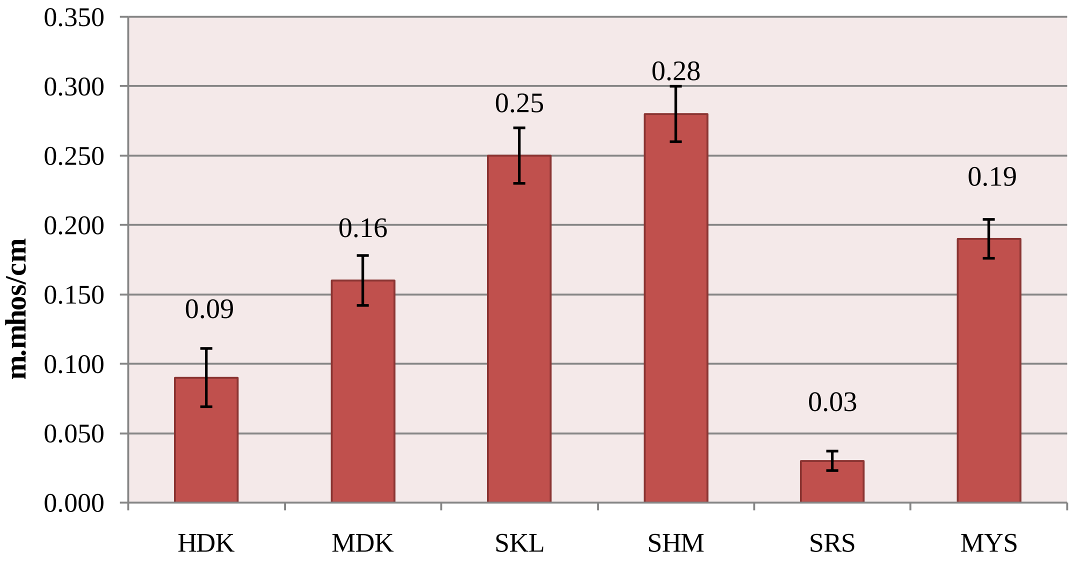

Fig. 3: Elecrtrical conductivity of soils in selected regions of the Western Ghats of Karnataka

Organic carbon (%): The level of soil organic matter determines the multiplication of microorganisms and makes the system more dynamic [17]. The organic carbon content in the soil samples drawn from six different regions of Western Ghats of Karnataka showed significant differences in their values. Among different regions, significantly high organic carbon content was found with H.D Kote region (1.59%). Further, Sirsi (0.97%), Madikeri (0.80%), Mysore (0.53%), Shimoga (0.51%) and Sakaleshpur (0.47%) regions found next best with respect to organic carbon content with later being the least (Fig. 4 and Table 2). The mean value of organic carbon content for all the selected regions of Western Ghats of Karnataka was 0.81% (Table 3). Organic carbon content in soils can be taken as an index for available nitrogen content in soils as highly significant relationship existed between them ($r=0.960$ at $P \leq 0.01$). However, Organic carbon content of soils showed positive non-significant relation with pH, while it was negatively non-significant association with electrical conductivity, available phosphorous and available potassium contents of soils (Tables 4 and 5). The soils of upland areas showed a regular decrease of organic carbon content with depth of soil, while the soils in inter-hill valleys exhibited an irregular trend with depth [18]. The soil organic matter content will be lower in low elevation than high elevation. This is due to the slow decomposition of organic residues [19, 20]. However, the nutrients stored in solid soil organic matter become available to the soil microbial community and plants as they are processed into smaller units by the soil microbial community [21].

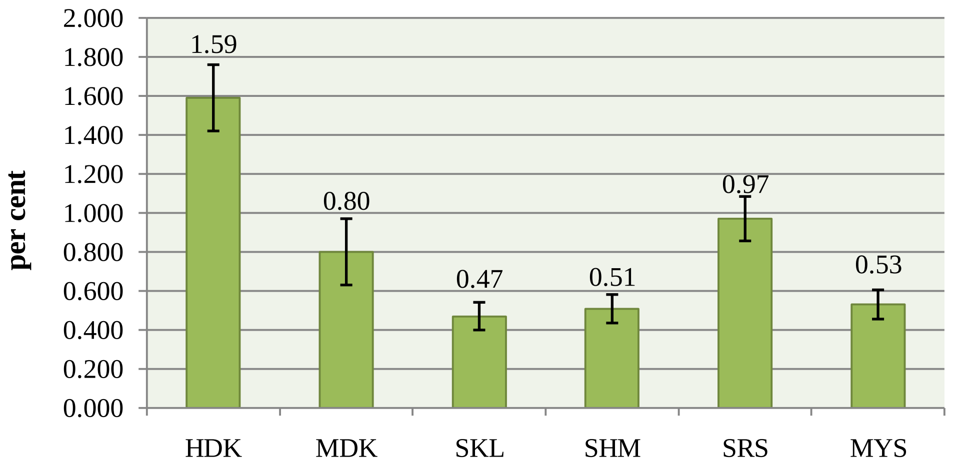

Fig. 4: Organic carbon content of soils in selected regions of the Western Ghats of Karnataka

Available Nitrogen (N): Nitrogen is an important factor affecting decomposition and this has confirmed [22, 20]. The availability of nitrogen is due to the regular addition of plant residues on the soil and decomposition [23]. The organic compounds are converted into inorganic nitrogen by certain bacteria, which can be absorbed by the plants. In total cycle, about 4-7 ton of nitrogen/ha is added to the soil each year [24]. The composite soil samples of the selected regions of Western Ghats of Karnataka were processed for estimating the available nitrogen content; the values being higher for H.D. Kote region (709.2 kg/ha) as compared to Madikeri (510.7), Sirsi (457.0), Mysore (310.8 kg/ha), Shimoga (269.1 kg/ha) and Sakaleshpur (250.6 kg/ha) (Fig. 5 and Table 2). The mean value of available nitrogen content for all the selected regions was (417.9 kg/ha) (Table 3). Though available nitrogen content in soils are greatly influenced by the organic carbon content of soils, but pH and available phosphorus content showed positive non-significant relationship with available nitrogen. However, the trend was in reverse order for electrical conductivity and available potassium content of soils (Tables 4 and 5). Soil has more than 90% of organic nitrogen but not directly available to plants and it converts into soluble organic compounds such as amino acids or inorganic forms like ammonium or nitrate before it can be used by plants. Most of the nitrate absorbed by roots is translocated to leaves by transpiration stream. Nitrate assimilation is therefore, mainly carried out in leaves and a small fraction in roots [3].

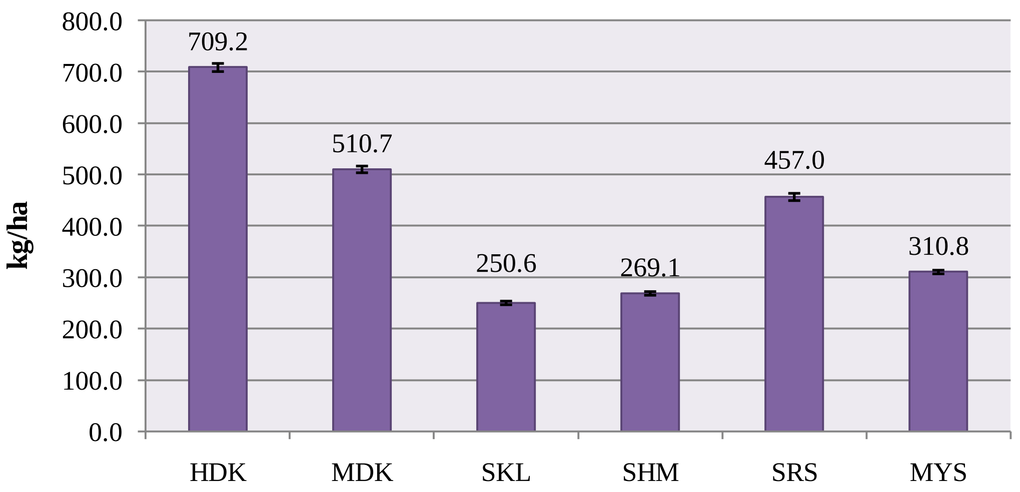

Fig. 5: Available nitrogen content of soils in selected regions of the Western Ghats of Karnataka

Available Phosphorous (P): Phosphorus is an essential constituent of protoplasm. It does not move readily through the soil and is not leached by rain or watering. Phosphorous is absorbed by the plants as H_2PO_4 HPO_4 or PO_4 depending upon soil pH. Most of the total phosphorous is tied up chemically in compound of limited solubility [25]. The available phosphorus content in the collected soils of selected regions of the Western Ghats of Karnataka showed significant variations with highest available phosphorus being registered in the soils of Madikeri (34.34 kg/ha), followed by Mysore (20.51 kg/ha), H.D.Kote (12.94 kg/ha), Shimoga (10.92 kg/ha) and Sakaleshpur (10.45 kg/ha) regions. However, available phosphorus content was lowest with Sirsi region (9.450 kg/ha) (Fig. 6 and Table 2). The overall mean value of available phosphorous content for all the selected regions was 16.44 kg/ha (Table 3). The availability of phosphorous content in soils was found positive significant relationship with pH, electrical conductivity, available nitrogen and available potassium, while it was negative non-significant correlation with organic content of soils (Tables 4 and 5). The highest available phosphorus content was recorded in soils of Kodagu region (66.19 kg/ha) as against the other regions of the Western Ghats of Karnataka (Dakshina Kannada, Udupi and Chickmagalur) [11].

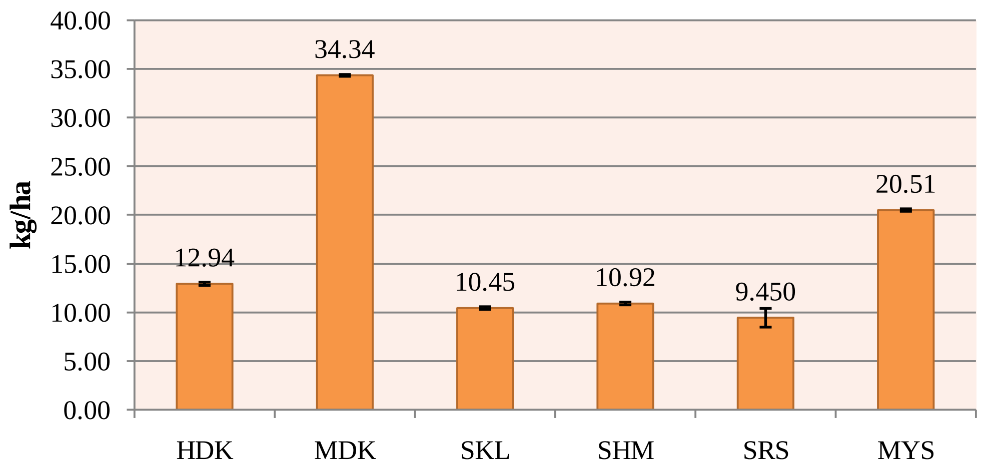

Fig. 6: Available phosphorous content of soils in selected regions of the Western Ghats of Karnataka

Available Potassium (K): Potassium is an activator of dozens of enzymes responsible for energy metabolism starch synthesis, nitrate reduction and also plays a major role in protection against disease by thickening the other cell walls of plants tissue [25]. In the study, significantly highest (717.0 kg/ha) available potassium content was recorded both in Madikeri and Sakaleshpur regions of Western Ghats of Karnataka and were closely followed by Shimoga (582.0 kg/ha), Mysore (493.0 kg/ha) and H.D. Kote (448.0 kg/ha) regions. However, Sirsi region of Western Ghats of Karnataka registered lowest available potassium content of 90.00 kg/ha (Fig. 7 and Table 2). The average value of available potassium content in selected regions was 507.8 kg/ha (Table 3). The values for the results of the variance – covariance matrix and correlation co-efficients on the available potassium content in soils established positive non-significant relationship with pH, electrical conductivity and available phosphorous, while it was negative non-significant correlation with organic carbon and available nitrogen content of soils. The available potassium content is medium to high in most of the soils of Karnataka except in lateritic soils of coastal plain and Western Ghats, whereas, it was shallow in red and low in black soils [26]. Highest available potassium content was recorded in Kodagu region (538 kg/ha) when compared to other regions of the Western Ghats of Karnataka (Dakshina Kannada, Udupi and Chickmagalur) [11].

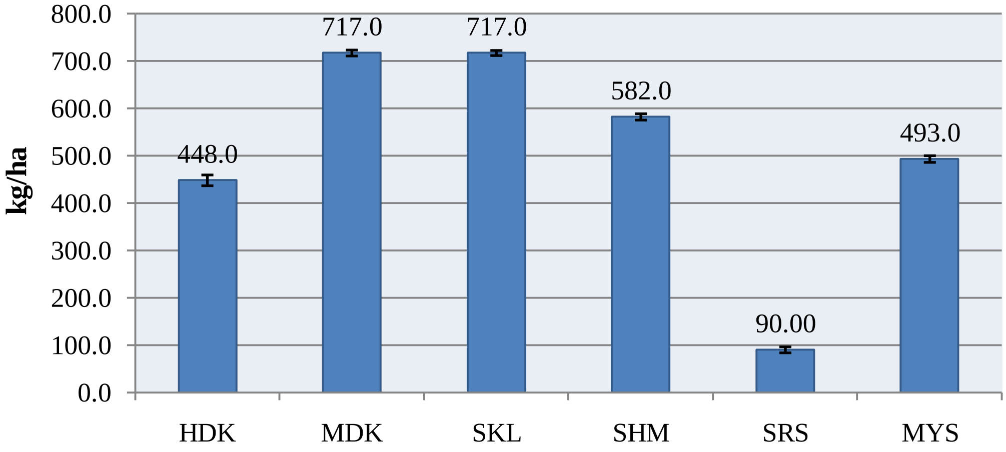

Fig. 7: Available potassium content of soils in selected regions of the Western Ghats of Karnataka

Table 2: Summary of ANOVA (statistical tests) for chemical properties of soils

Statistical test	pH	Electrical conductivity	Organic carbon*	Available Nitrogen	Available Phosphorus	Available Potassium
SE(m) ±	0.214	0.018	0.120	5.664	0.134	7.455
SE(d) ±	0.302	0.025	0.170	8.011	0.189	10.54
C.D. at 5%	0.627	0.052	0.354	16.63	0.393	21.89
C.V. (%)	7.110	23.62	33.19	3.031	1.822	3.283

*Statistical tests for the angular transformed values

Table 3: Mean values of chemical properties of soils

Parameter	Mean#	Standard Deviation	Standard Error
pH	6.72	1.11	0.45
Electrical conductivity (m.mhos/cm)	0.17	0.09	0.04
Organic carbon (%)	0.81	0.43	0.18
Available nitrogen (kg/ha)	417.9	176.9	72.25
Available phosphorus (kg/ha)	16.44	9.64	3.94
Available potassium (kg/ha)	507.8	232.98	95.11

#Data of six selected regions of Western Ghats of Karnataka each consists of five replications

Table 4: Correlation co-efficient of chemical properties of soils

Variable	pH	EC	OC	N	P	K
pH	1.000					
EC	0.226^{NS}	1.000				
OC	0.023^{NS}	-0.741^{NS}	1.000			
N	0.201^{NS}	-0.734^{NS}	0.960**	1.000		
P	0.737^{NS}	0.016^{NS}	-0.071^{NS}	0.206^{NS}	1.000	
K	0.446^{NS}	0.777^{NS}	-0.410^{NS}	-0.285^{NS}	0.459^{NS}	1.000

**Significant at $P \leq 0.01$, NS: Non-significant

Table 5: Variance - covariance matrix of chemical properties of soils

Variable	pH	EC	OC	N	P	K
pH	1.017					
EC	0.020	0.007				
OC	0.009	-0.025	0.153			
N	32.776	-10.267	60.725	26,099.56		
P	6.542	0.012	-0.244	292.645	77.406	
K	95.539	14.298	-34.163	-9,799.50	858.578	45,231.11

CONCLUSION

The results of the study revealed that, pH and EC of soils ranges from 5.25 (Sirsi) - 7.83 (Madikeri) and 0.03 (Sirsi) - 0.28 m.mhos/cm (Shimoga), respectively. Organic carbon and available nitrogen contents were significantly more (1.59% and 709.2 kg/ha) with H.D. Kote and Sakaleshpur regions, while the soils of Madikeri region had higher available phosphorus content (34.34 kg/ha). Both Madikeri and Sakaleshpur regions recorded highest potassium content of 717.0 kg/ha. It can be concluded that the soils of Sakaleshpur, H.D. Kote and Madikeri regions of Western Ghats of Karanataka were found better for exploitation of castor (wild/tree).

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REFERENCES

1. Doran JW and Parkin TB; Defining and assessing soil quality. In: Defining soil Quality for a Sustainable Environment. (Eds.) J.W. Doran, D.C. Coleman and D.F. Benzdicek, Madison Soil Sci. Soc. America, 1994: 3-21.
2. Paudel S and Sha JP; Physio-chemical characteristics of soil in tropical sal (*Shorea robusta* Gaertn.) forest in eastern Nepal. Himalayan J. Sci., 2003, 1(2): 107-110.
3. Reddy TY and Reddy GHS; Principles of Agronomy. Kalyani Publishers, New Delhi, 2010: 527.
4. Daniel RJR; Taxonomic uncertainties and conservation assessment of the Western ghats. Curr. Sci., 1997, 43: 1-8.
5. Anonymous; Castor - Package of Practices for Increasing Production. (Eds.) D.M. Hegde and D. Patil, Directorate of Oilseeds Research, Hyderabad, 2000: 20.
6. Malaviya DD, Poshiya VK and Dhaduk HL; Oilseeds - Castor. In: Techniques and Management of Field Crop Production. (Eds.) P.S. Rathore, Pub. Agrobios (India), Jodhpur, 2000: 197-214.
7. Jackson ML; Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi, 1973: 498.
8. Subbiah BV and Asija GL; A rapid procedure for the estimation of available nitrogen in soils. Curr. Sci., 1956, 258: 518-522.
9. Anonymous; OPSTAT Statistical Package. O.P. Sheoran, Programmer, Computer Section, Chaudhury Charan Singh Hisar Agriculture University, Hisar, India, 2013.
10. Gurumani N; An Introduction to Biostatistics. Second Revised Edition, MJP Publishers, Chennai, 2008: 405.
11. Rajkumar HG, Seema HS and Sunil Kumar CP; Diversity of arbuscular mycorrhizal fungi associated with some medicinal plants in Western Ghats of Karnataka region, India. World J. Sci. Tech., 2012, 2(1):13-20.
12. Das PK, Nath S and Banerjee SK; Characteristics of the soils of sub alpine region in eastern Himalayas. J. Soc. Soil Sci., 1988, 36: 576-580.
13. Sharma PD and Oaher QA; Characterization of some Himalayan protected and erode forest soils. J. Soc. Soil Sci., 1989, 37: 113 -120.
14. Rickard WH; The influence of grease wool on soil moisture penetration and soil Chemistry, North West Sci., 1965, 39: 36-42.
15. Sivasankaran K, Mithyantha MS, Natesan S and Subbarayappa CT; Physico-chemical properties and nutrient management of red and lateritic soils under plantation crops in Southern India. NBSS Publications, 1993, 37: 280.
16. Bhadrapur TG and Seshagiri Rao T; Salt affected black Soils, chemical characteristics and sodium divalent cation exchange relationship. J. Indian Soc. Soil Sci., 1977, 25 (1): 11-17.
17. Prescott CE, Taylor BR, Person WFJ, Doral M and Parkinson D; Nutrient release from decomposing litter in rocky mountain coniferous forest: Influence of nutrient cycling in primary and old secondary rain forest. Applied Geography, 1993, **7**: 135-152.

18. Bhaskar BP, Mishra JP, Baruah U, Vadivelu S, Sen TK, Butte PS and Dutta DP; Soils on *Jhum* cultivated hill slopes of Narang – Kongripara watershed in Meghalaya. J. Indian Soc. Soil Sci., 2004, 52: 125-133.
19. Raina AK, Tha MN and Pharasi SC; Forest soil: Vegetation relationship in Mussoorie forest division (Uttaranchal). The Indian Forester, 2001, 127**:** 883 – 890.
20. Jeeva S; Impact of mining on plant diversity and community structure of aquatic and terrestrial ecosystems of Jaintia hills Meghalaya, Ph.D. Thesis, Centre for Advanced Studies in Botany, School of Life Sciences, North – Eastern Hill University, Shillong, Meghalaya, 2007.
21. Schimel JP and Bennett J; Nitrogen mineralization: Challenges of a changing paradigm. Ecology, 2004, 85: 591-602.
22. Pandey V and Singh; Leaf litter decomposition in an Oak- conifer forest in Himalayas. The effect of climate and chemical composition. Forestry, 1982, 55: 47-59.
23. Bhola N and Misra VK; Influence of nitrogen fixing trees on the status of some soils micronutrients. Indian J. For., 1998, 21**:** 103-107.
24. De AK; Environmental Chemistry. New Age International Ltd. Pub., New Delhi, 1996: 8.
25. Brady NC; The nature and properties of soils. Mac Millan Pub. Company, 1984: 200-362.
26. Shivaprasad CR, Reddy RS, Sehgal J and Velayutham M; Soils of Karnataka for Optimizing Land Use. NBSS Publications, 1998, 47: 15.